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Genetic Progress

Crossbreeding has dramatically improved our livestock. Better poultry, hogs, sheep, and beef cattle (see pp. 10 and 11) have come from crossing and selecting superior offspring within animal species.

Now, geneticists are making wider crosses—between animals from different species—that offer even more potential for improving livestock. The chicken-quail hybrid pictured on the cover is the result of one of these wide, interspecific crosses.

Through this and other genetic research, scientists are gaining basic knowledge of the biological processes of animals (see pp. 3 and 4). And, since interspecific crosses produce gene combinations that don't otherwise occur in nature, such crossing and selection may produce animals with desirable characteristics that aren't found when natural reproduction occurs within a species.

The chicken-quail hybrid, for example, is intermediate in size between its parents. If continued crossing and selection produces a bird of this size with the taste of a quail and body conformation of a chicken, new markets might result.

Improvement in domestic poultry may come from ARS-sponsored research in India, where scientists are making and evaluating interspecific crosses between Leghorns and species native to India.

The Leghorn, geneticists believe, may have reached a plateau in its egg-laying ability. Egg production steadily has been improved through selection within the breed, but scientists doubt that much further improvement is possible with this method.

Introducing genes from birds as different from Leghorns as the species native to India might change the picture. At first, such a cross would not approach Leghorns in egg production.

However, egg production could be improved by repeated crossing and selection of superior individuals. Eventually, the egg production of the new strain might exceed that of our present Leghorns.

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CHICKEN-QUAIL HYBRID

This fertile, intermediate species between quail and chickens could help geneticists direct animal evolution.

PLANT GENETICISTS have made tremendous strides by selecting characteristics from one species and passing the genes that carry those characteristics to a closely related species. Hybrid corn, nematode-resistant soybeans, and rust-resistant and short-straw wheat are among the results.

Progress in animal genetics, however, has been slower—primarily because animals are immensely more complicated organisms, but also because man has much to learn about how closely related species have maintained their similarities and differences throughout the long process of evolution.

To help find how closely various avian species are related, ARS cytogeneticist P. A. Sarvella at Beltsville, Md., is determining the chromosome number and chromosome pairing in different birds.

At present, her basic research is aimed at giving scientists a better picture of the genetic and evolutionary history in part of the animal kingdom. But some time in the future the research may enable poultry breeders to transfer desirable characteristics—such as disease resistance—from wild birds to domestic poultry.

Central to the genetic research is a hybrid bird produced by inseminating female Japanese quail with semen

ST–1860–3

P. A. Sarvella injects the hybrid with hormones in an attempt to increase fertility. Technician Melvin Gehman holds the bird.

from Dark Cornish roosters. It is not the first time scientists have crossed chickens with quail, but it may be the most successful. Of the eggs produced by these hybrid birds, 10—or about 1.5 percent—hatched; 8 offspring have lived to maturity.

All of the crossbreds appear normal—in contrast to an earlier ARS cross of chickens with turkeys (AGR. RES., Jan. 1961, p. 10). But like the chicken-turkey hybrids, the chicken-quail hybrids are all male and are apparently sterile.

In most ways, however, the hybrids strike an average between their parents. Quail eggs hatch in 18 days and chicken eggs in 21; eggs from the crosses hatch in 19 days. Quail normally mature in 6 weeks and chickens in 19 to 20 weeks; the hybrids mature in about 12 weeks. In size and weight, also, the hybrids fall between their parents.

Cytogeneticist Sarvella and ARS geneticist H. L. Marks now are injecting the hybrids with hormones in an attempt to increase any potential fertility the birds may have. Such induced fertility would be valuable for two reasons. First, the hybrids would produce gametes, or germ cells, that could be studied for chromosomes of similar ancestry that have been passed on by both parents. Gametes (sperm cells in males; ova in females) are produced with half the number of chromosomes that normal body cells have.

In the formation of typical gamete cells, there is an actual reduction division in the cells. During this reduction division, one chromosome from one parent pairs with the similar chromosome from the other parent. In the end, the original cell has divided into four cells, each with one-half the number of chromosomes of the original cell.

When the parents are of different species, however, the chromosomes from one parent will pair with those from the other parent in a direct relationship to the evolutionary closeness of their ancestry.

A second value of induced fertility is the more remote possibility that scientists would then be able to backcross the hybrids with quail and chickens. Backcrossing between the hybrid and its parent species could stabilize a new species intermediate between quail and chickens.

In plant breeding, scientists have frequently found it necessary, when passing a desired characteristic from one species to another, to pass the gene through a third or intermediate species. Rust resistance, for instance, was passed from a wild grass to wheat through emmer, a feed grain.

A fertile intermediate species between quail and chickens could be a step in controlling and directing evolution. It could give scientists additional access to the limitless pool of genetic characteristics in wild and domestic birds. ■

ST-1859-1

The Dark Cornish rooster held by Melvin Gehman (left) and the female Japanese quail held by J. M. Singer, ARS information officer (right), are parents of the chicken-quail hybrid in P. A. Sarvella's hand (center).

P.L. 480 RESEARCH

ENZYMES FOR CHEESEMAKING

INDIAN SCIENTISTS have produced bacterial enzymes that can be used in place of calf rennet in cheesemaking.

As a result of this and related research, scientists expect that bacterial "rennets" will be produced industrially, and their use will lead to new and expanded domestic and export markets for cheese.

The cheesemaking research in India is supported by a Public Law 480 grant, awarded by ARS to the National Dairy Research Institute in Karnal, India. Such grants are made in local currencies obtained from the sale of U.S. surplus foods under Public Law 480.

The coagulation of milk by a clotting enzyme is a key step in cheesemaking. Rennet, an extract of the stomach lining of milk-fed calves, contains the clotting enzyme rennin. It produces semi-solid curd that is separated from the whey; salted, pressed, and aged; and becomes cheese.

There is a shortage of calf rennet in the United States, and its use is limited in large areas of the world because of religious beliefs. The shortage in this country is the result of increased cheese production to satisfy the domestic market and of feeding practices which greatly reduce the amount of milk in calf diets. The rennin content of tissue in calves raised on milk-replacers is very low.

To find substitutes for rennet, dairy bacteriologist A. T. Dudani and his staff surveyed 400 kinds and types of microorganisms. They found 6 enzymes—5 bacteria and 1 mold—that can produce milk-coagulating enzymes more active than calf rennet.

These enzymes can be easily and cheaply produced by growing the organisms on wheat bran, peanut cake, and dairy byproducts. The researchers found cheddar cheese made from these vegetable-origin rennets generally comparable to animal rennet cheese. ■

SOYBEAN SAPONINS HARMLESS

ARS-SPONSORED research in Israel has provided new proof that soybean saponins are harmless in food.

The findings of chemist Aron Bondi and associates at Hebrew University, Rehovot, support ARS efforts to develop soy foods for people in protein-short countries.

The work, conducted under a Public Law 480 grant, was sponsored by the ARS Northern regional research laboratory at Peoria, Ill. This laboratory has developed new soy foods and processes and is the center of ARS research on soy-flour protein.

Saponins are soap-like components found in many plants. Some saponins are extracted from the South American soapbark tree and from soapwort, a perennial herb of Europe and the United States, for use in detergents, emulsifiers, and foaming agents for fire extinguishers. Some are harmful if fed in sufficiently large amounts.

The Israeli scientists found, however, that soy saponins differ from those in other plants. They are minor constituents in soybeans, present to the extent of only 0.5 percent.

Isolated soybean saponins, however, did not harm chicks, rats, and mice in the Israeli studies even when fed at a level three times higher than the level in a diet including 50 percent soy-flour. ARS scientists have noted that pure soybean saponins prepared by Bondi and his associates are tasteless.

This new evidence confirms what most nutritionists and livestock feeders have accepted, say ARS researchers. Over the past 30 years, some 300 million tons of soybean meal has been fed to livestock and poultry.

Soybean foods have been widely used and studied, and have been tested clinically with babies (AGR. RES., August 1966, p. 10). In these tests scientists found no physiological symptoms that could be attributed to toxicity of saponins. ■

R. A. Ahrens weighs a rat while Mrs. Welsh records data.

RATS DON'T BENEFIT FROM

High-Fat Diet

RESTRICTED DIETS high in fat and low in carbohydrates are no more effective for reducing true body weight than restricted diets low in fat, although the scales may indicate otherwise.

ARS and State scientists reached this conclusion after comparing rats fed high-fat and low-fat diets in studies at College Park, Md.

Susan Welsh, University of Maryland graduate assistant, lifts a rat from its cage to start its exercise.

ST–1743–2

Rats on high-fat restricted diets apparently weighed less than those on low-fat diets, but this was because they carried lighter loads in their digestive systems.

Otherwise, the researchers found, the weight of a rat is no different whether the reducing diet is high or low in fat; but when the diet is high in fat, the proportion of fat in the body is generally greater.

The cooperating researchers also reaffirmed that exercise, unlike a high-fat diet, does reduce true body weight—by 18 percent for rats on a restricted, low-fat diet. Under the same conditions, exercise reduced fat in the body 65 percent.

ARS NUTRITIONISTS R. A. Ahrens and J. E. Wilson, Jr., and University of Maryland physical education researchers D. L. Hanson, J. A. Lorenzen, and A. E. Morris used mature male rats kept in individual cages. Before the study started, most rats had grown heavy by eating all they wanted of a feed high in carbohydrates and low in fat.

During the 6-week study, half of the rats were placed on a high-fat, low-carbohydrate diet. Cornstarch, the carbohydrate source, was reduced from 57 percent in the previous feed to 16 percent; beef tallow, the fat source, was raised from 7 to 30 percent. The rest of the colony stayed on their previous diet.

Some of the rats were allowed to eat all they wanted; for others on both diets, meal size was cut 35 percent. To provide exercise, some rats on each feeding program were made to swim for 1 hour per day. The other rats remained caged with no special opportunity for exercise.

Using rats that received a free feed of a low-fat diet and no exercise as the basis for comparison, the researchers found that feed restriction reduced live body weight 21 percent; exercise reduced live body weight another 10 percent; and substitution of a high-fat for a low-fat diet reduced live weight a further 2 percent.

Nutritionists know that gross live weight can be misleading when establishing the result of a reducing diet, so cooperators in the ARS-State trial determined the actual weight of separate parts of the body.

Thus, they found that the contribution to lower live weight made by the

high-fat diet was due only to a lighter load in the intestinal tracts of the rats. The high-fat diet weighed less per unit of volume; and the rats that ate restricted amounts of this feed may have drunk less water and digested and passed out their feed at a faster rate than those on a low-fat diet.

When the weight of material in the digestive tract was excluded, the ratio of fat to carbohydrate in the ration hardly changed the weight of rats. This was true whether or not rats were exercised and whether or not their rations were restricted.

THUS, THE SCIENTISTS say that a given amount of calories did not change body weight whether these calories were provided by a high-fat or a low-fat diet.

For rats that were exercised and on restricted feed, however, the proportion of fat in the body tissues of rats on a high-fat diet was 61 percent greater than for rats on a low-fat diet. Major fat deposits in their bodies also were greater. For example, fat around the kidneys (the largest fat pads of rats) was nearly 58 percent greater in weight for the rats on the high-fat diet.

Data showed that exercise slows conversion of feed into body fat for heavy rats, but thin rats were much less affected. With free access to feed, the light rats had nearly the same proportion of their body weight in fat, whether they were exercised or not.

The scientists feel that their findings are valid in general terms. In further research, they plan to clarify certain details. Since rats normally avoid swimming, the researchers will see if results differ with another form of exercise, such as running.

In future research, the University of Maryland scientists plan to test human volunteers to check the extent to which the findings with rats can be applied to man.■

Hybrid Buffelgrass From

NEW PLANT BREEDING METHOD

A SINGLE SEXUAL buffelgrass plant, found by chance on a ranch in Texas, has made it possible to hybridize this forage grass for the first time.

The finding led to development of a new plant breeding method in cooperative research by ARS and the Texas Agricultural Experiment Station, College Station.

The method involves control and manipulation of apomixis, an asexual type of reproduction in which seeds are formed without fertilization. With the new method, scientists developed and released Higgins buffelgrass, the first artificially produced apomictic crop variety.

Control of apomixis has not been possible in the past, and there has been little hope of improving apomictic plants. Hybridization has been impossible, and since progenies from this type of reproduction are completely uniform and identical to the mother plant, no progress can be made through selection.

Apomixis occurs in buffelgrass, and in other plants as well. However, for the new method to work with other crops it would be necessary to start with a sexual plant as was the case with buffelgrass.

The sexual plant, TAM–CRD Z–1s, may be a mutant from an asexual strain. It was discovered growing adjacent to fields of Blue and T–4464 (common) buffelgrass on the Pat Higgins ranch near Southerland Springs, Tex. Higgins donated tillers of the original plant to the Cooperative Grass Cytogenetics Project at Texas A. & M. University.

In subsequent research, ARS geneticist E. C. Bashaw and ARS agronomist C. M. Taliaferro discovered that apomictic reproduction is inherited in buffelgrass and can be manipulated like other genetically controlled characteristics.

The sexual TAM–CRD B–1s may be the female parent in hybridization with the asexual plant, or it may be self-pollinated to produce a variable first generation population. Hybridization with the asexual plant gives a ratio of 5 sexual to 3 asexual progeny. Self-pollinating the sexual plant gives a ratio of about 13 sexual to 3 asexual progeny. The asexual progeny from both kinds of reproduction are identical with the parents and. consequently, superior individuals may be produced and evaluated as potential new varieties.

Buffelgrass, an excellent warm-season grass used for pasture in some southern States, withstands fairly heavy grazing, but present varieties lack winter hardiness. Limited seed supplies of Higgins buffelgrass should be available to farmers for 1968 plantings.

Higgins, an apomictic strain selected from first generation progeny of TAM–CRD B–1s, produces a high yield of good quality seed and resembles Blue in good rhizome development, rapid spread, persistence, and forage yield.

TAM–CRD B–1s has been released to plant breeders to develop better buffelgrass strains and varieties.■

FOR HIGH-PRODUCING COWS . . .

EXTRA CONCENTRATES DON'

FEEDING HIGH-PRODUCING dairy cows less hay to encourage them to eat more concentrates doesn't pay.

ARS trials show that this practice provides no more feed energy, results in no additional milk, and decreases the fat percentage of the milk.

Test results also show that it may not be necessary to feed more concentrates per pound of milk to high-producing than to low-producing cows. The same amount of feed energy is required per pound of milk—for the 10th as for the 80th pound.

Dairymen commonly feed cows all the hay they will eat and then add concentrates in proportion to milk yield, a pound of concentrates for a specified number of pounds of milk produced that day. With high-producing cows at their peak of production, strict adherence to this formula provides more concentrates than the cow will eat. When this happens, some farmers reduce the hay ration to encourage cows to eat all the allotted concentrates.

ARS dairy nutritionists W. P. Flatt and P. W. Moe at Beltsville, Md., studied feed utilization of high-producing dairy cows through complete lactations. The cows got four different rations: all high-quality alfalfa hay; 60 percent hay and 40 percent high-protein, finely ground concentrate mix; 40 percent hay and 60 percent concentrates; and 20 percent hay and 80 percent concentrates.

The protein percentage of the ration was kept constant, regardless of the concentrate percentage, so the nutritionists could compare utilization of energy at various levels of intake from both concentrates and forage without interference from varying protein percentages.

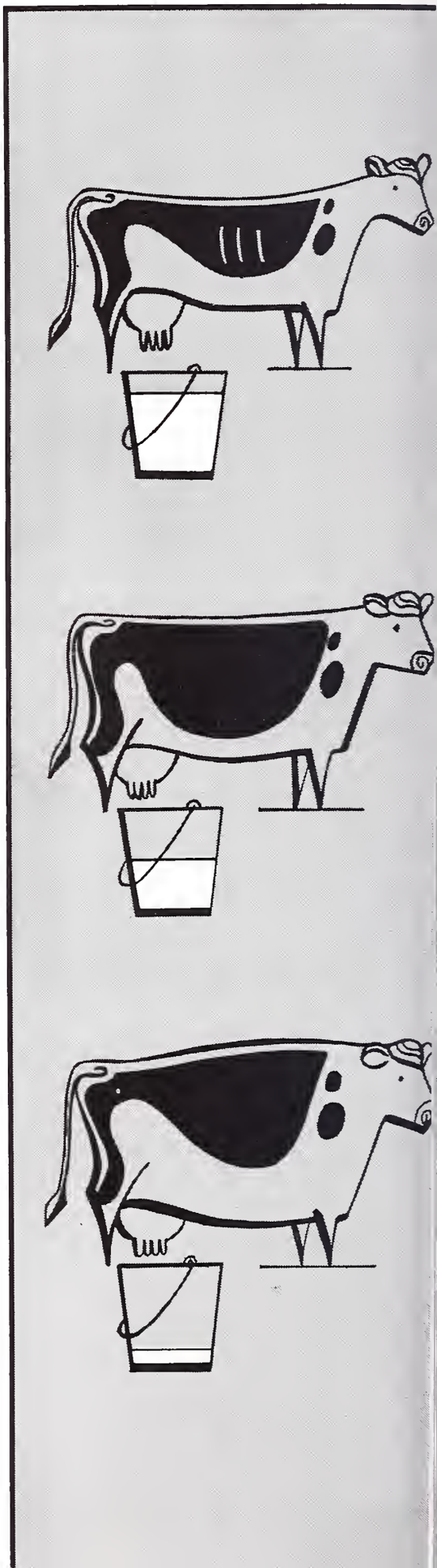
Flatt and Moe found that during the first 2 months of lactation, the higher levels of concentrate feeding did not result in higher yields of milk when the milk was corrected to a constant fat percentage.

Cows fed concentrates as 40 percent of their rations produced milk with 4.2 percent fat, but with rations containing 60 percent concentrates, milk fat dropped to 3.4 percent; and with 80 percent concentrates, to 2.7 percent. This difference persisted to a lesser degree at later stages of lactation.

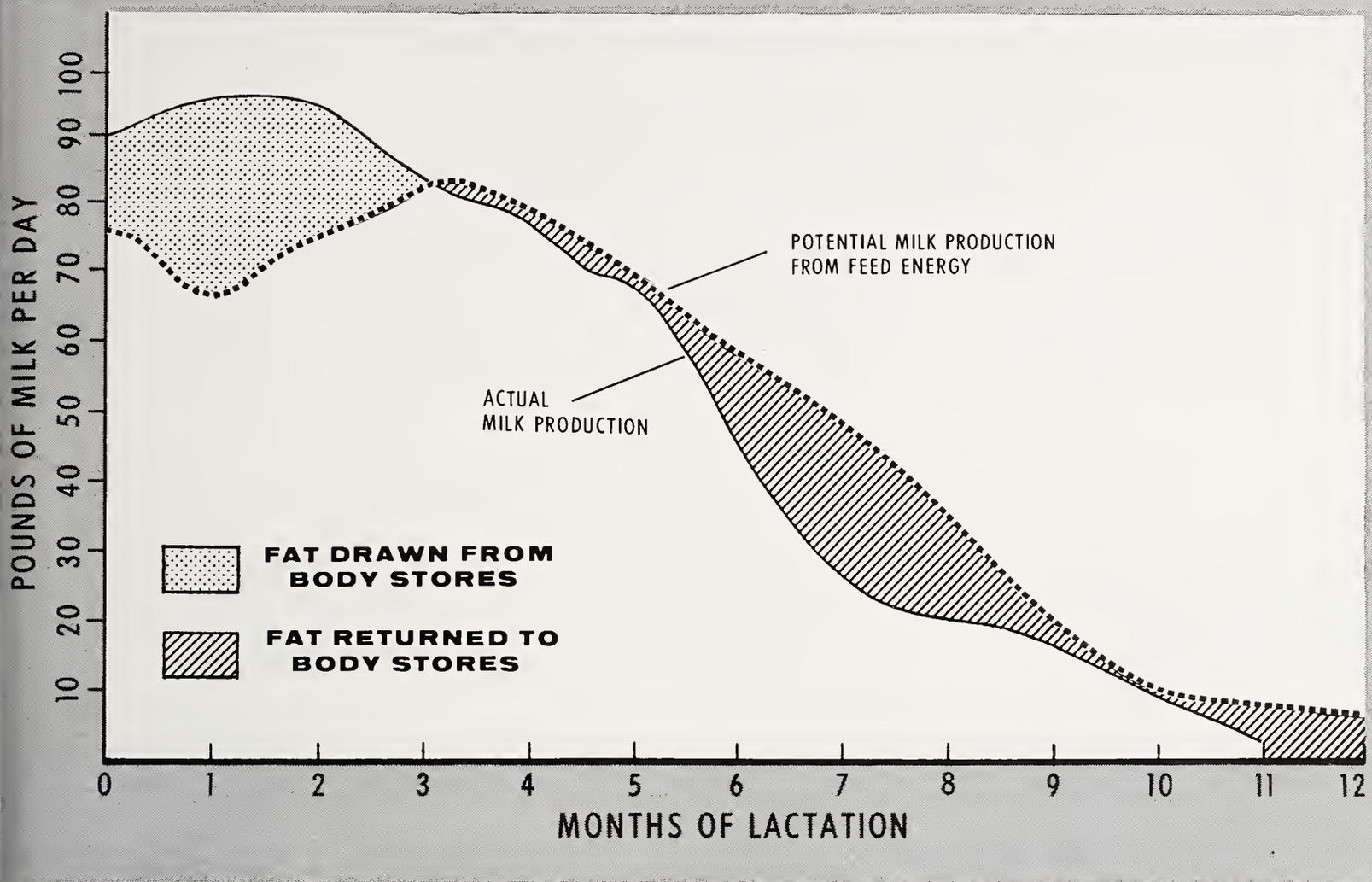
The trials also showed that dairymen needn't worry if cows that produce over 60 pounds of milk per day don't digest their feed as well as cows that eat less and produce less.

As the efficiency of digestion goes down with increased intake, less digested energy is channelled into production of urine, rumen gases, and body heat, and more is therefore available for milk production.

Flatt and Moe are now studying other types of rations to see if these compensating effects always occur. Preliminary findings show that when concentrates are coarsely ground, cows don't compensate as much for lower digestion in the latter stages of their lactations.■



PAY



CONCENTRATES AND BODY FAT

A rule of thumb for feeding dairy cows calls for 1 pound of concentrates for a specified number of pounds of milk produced. If a superior cow is given a full feed of good forage, she may not be able to eat all the concentrates to which she is "entitled" during her lactation peak.

The best cows fill the gap between energy in feed and energy required for milk by drawing on stored body fat. Lorna, the star producer in Flatt and Moe's string, for example, produced 3,000 pounds of milk unaccounted for by feed intake by withdrawing 330 pounds of body fat during the first 89 days of one lactation (AGR. RES., December 1965, p. 3).

Late in lactation, a cow processes concentrates into body fat as efficiently as into milk. The time to feed the extra concentrates and build up the body fat store is during the waning months of the previous lactation, ARS nutritionists say.

The graph and drawings illustrate that a high-producing cow is not able to consume enough feed to meet energy demands in early (peak) lactation. Then, the high-producing cow is underfed and draws from body stores (first drawing). After the peak, feed consumption and milk production are in balance (second drawing). At the end of lactation, feeds (including forage and concentrates) supply more energy than required for milk production and the cow replaces body fat (third drawing).

Crossbreeding Beef Cattle PAYS

A good herd of beef cattle may bring greater returns with systematic crossbreeding than with conventional straight breeding.

ARS experiments show that crossbreeding yields 3 percent more calves that are 5 percent heavier at weaning and return nearly $9 more in carcass value.

Hybrid vigor, the response in an animal from the cross of parents carrying many unlike genes, is the reason for the increase, ARS scientists say. Hybrid vigor is at work when crossbred offspring are more productive than straightbred offspring from the same parents.

Why hybrid vigor occurs is not completely known. It may result from unlike genes for the same trait contributed by the two parents or from undesirable recessive genes in each breed that are masked by dominant genes of the other breed.

In general, crossbred calves are more vigorous and grow faster than straightbred calves because of the added boost given by new gene combinations.

CROSSBRED CALVES

In recent cooperative trials at ARS and State Agricultural Experiment Stations, scientists compared the performance of crossbred calves with that of straightbred calves sired by the same bulls and raised by comparable cows.

Cows for the project came from herds in Nebraska, Montana, and Colorado, and bulls originated from an even greater variety of sources, making for a broad genetic representation of each breed.

Four years of tests showed that the average overall performance of the crossbred offspring was better than that of the *superior* parental breed, not just the average of the two parental breeds.

Crossbred calves weighed 437 pounds or 5 percent more than straightbreds when weaned at 200 days, and 3 percent more crossbred calves lived to reach weaning.

Herefords, Angus, and Shorthorns were used in the crossbreeding trials at the Fort Robinson Beef Cattle Research Station in Nebraska. Herefords crossed with Angus and Shorthorns showed about the same amount of hybrid vigor, but Angus-Shorthorn calves had less hybrid vigor than the other two breed crosses.

Herefords, Angus, and Charolais were crossbred at the U.S. Range Livestock Experiment Station, at Miles City, Mont. In limited trials there, Brown Swiss cows also were mated to beef bulls.

Charolais crosses did best because they had fast, early growth. Highest returns came when Charolais were the female parents. Crossbred calves from Brown Swiss cows gained well because these cows provided ample milk for their calves.

CROSSBRED STEERS

Crossbred and straightbred steers produced at Fort Robinson were fed individually from weaning to slaughter. When steers were 15 months old, crossbreds were 29 pounds heavier than straightbreds.

During the feeding period, average daily gains of crossbred steers were about 3 percent larger than those of straightbred steers, but the advantage narrowed toward the end of the feeding period. Differences in feed efficiency between crossbreds and straightbreds were small.

Boneless, closely trimmed retail cuts from crossbred steers had the same composition and grade as meat from straightbreds fed to the same market weight. Overall value of the meat from crossbreds, based on 1964 prices, was $8.81 greater after taking feed costs from weaning to slaughter into account.

CROSSBRED MOTHERS

Replacements for the beef herd on a crossbreeding program may come from crossbred heifers, whose hybrid vigor helps the next generation to a good start.

At birth, crossbred replacement heifers start with a 3-pound weight advantage; at 18 months, they average 50 pounds heavier than their straightbred half-sisters, according to ARS data.

Although the hybrid vigor of a heifer can help give her calf a healthy start, a hybrid dam cannot pass hybrid vigor to her offspring. Hybrid vigor has to be regenerated for each individual calf by mating cows and bulls of unlike breeding.

On a crossbreeding program, as on a straight breeding program, breeders have to select replacements for superior growth, feed efficiency, ability as mothers, and indications of capacity to produce good beef.

ARS researchers fed part of the crossbred and straightbred heifers 4½ pounds of concentrate per head per day plus liberal rations of hay during their first winter to bring them to puberty early. The crossbreds reached puberty 41 days earlier.

Geneticists say that hybrid vigor acts directly to advance puberty; the higher gains, which also help advance puberty, were responsible for one-fourth to one-half of the advance in date of puberty.

Scientists compared crossbreds and straightbreds as mothers by breeding both types of cows to the same bulls of a different breed.

Preliminary data from 3 years of trials show that 92 percent of the crossbred cows became pregnant during a 70-day breeding season, while 86 percent of the straightbreds became pregnant during that time.

About 65 percent of the crossbreds became pregnant on the first service, compared to 54 percent of the straightbreds. As a result, the calving season of the crossbreds was less strung out; 64 percent of the crossbreds calved the first 20 days of the season, compared to 57 percent of the straightbreds.

Crossbred mothers weaned 17 percent larger calf crops than straightbred mothers the first year of trial and 6 and 10 percent larger the next 2 years. At the same time, calves from crossbred mothers averaged 17, 20, and 31 pounds heavier at weaning.

ARS scientists K. E. Gregory, J. E. Ingalls, O. F. Pahnish, J. J. Urick, and J. N. Wiltbank; and Nebraska Agricultural Experiment Station researchers C. W. Kasson, R. M. Koch, J. A. Rothlisberger, W. W. Rowden, L. A. Swiger, and L. J. Sumption took part in various phases of the crossbreeding studies.

Crossbred calves on a feedlot at Miles City, Mont., show color patterns reminiscent of Hereford, Angus, Charolais, and Brown Swiss ancestry.

PN–1475

OXYGEN Cuts Cherry Scald

ADDING OXYGEN to the water in cherry storage tanks may be the answer to the scald problem that has plagued red tart cherry processors for years.

Cherry scald is the movement of red pigment from the skin to the flesh of the cherry. It occurs only on bruised cherries. In spite of the efforts to harvest, handle, and cool cherries rapidly and carefully, some are bruised and this increases the scald danger.

Cherries are normally dumped into water tanks, called soak tanks, before pitting and processing. The soak tank provides a convenient method of cleaning, cooling, and storing large quantities of fresh cherries. The cherries also firm up while in the soak tank.

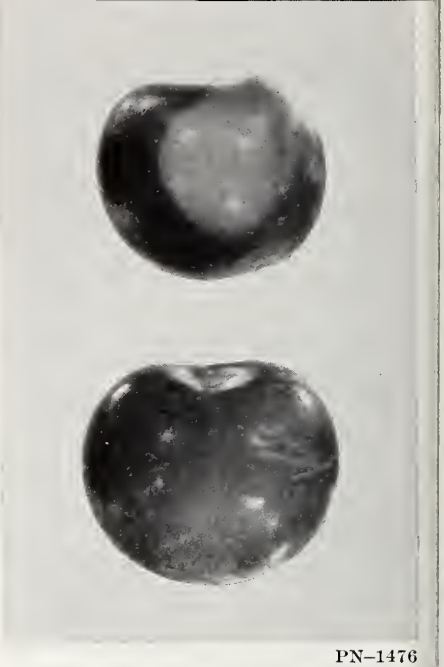
Oxygen is removed from the water by the normal respiration process of the cherries. And, because respiration increases with bruising, the greater the bruising, the greater the loss of oxygen from the water. Under present methods, the same water is recirculated through the soak tanks from a refrigeration unit with no addition of oxygen to the water.

As a result of studies at Beltsville, Md., and at the processing plant in Pennsylvania, ARS plant physiologist E. E. Dekazos believes that aerated tanks which would keep oxygen content of the water above 2 parts per million (p.p.m.) could reduce losses in grade when field handling problems cause extensive bruising.

Dekazos used commercial tanks at the processing plant and experimental tanks built for the study. He laid a commercial aeration system of perforated tubing in the bottom of each tank in a grid pattern. The system is designed to release air bubbles of the most efficient size to transfer oxygen to the water.

Dekazos covered the tubing with a metal mesh to keep the cherries from settling over the air outlets. He used other tanks without aeration systems for comparison.

The researcher dumped cherries into the tanks and took readings periodically at several locations in the tanks. When the cherries were removed for processing, he examined them for scald. The results showed a definite relationship between the oxygen concentration in the water and the percentage of scald.



PN–1476

The top cherry shows heavy scald; the other, showing no scald, was unbruised during processing.

Bruised cherries in water with less than 2 p.p.m. oxygen developed a higher percentage of scald. In one tank, for example, an oxygen range of 1 to 2 p.p.m. resulted in 9.5 percent scald damage; another tank with an oxygen range of 2.3 to 7 p.p.m. had only 1 percent scald damage. Also, cherries in the aerated tanks had a better color than those in the unaerated tanks.■

NITROGEN Prevents Lettuce Spotting

ADDING LIQUID NITROGEN to the atmosphere inside shipping trailers significantly reduces russet spotting of lettuce while it is in transit to market.

More lettuce is turned down at the market because of this disorder than for any other reason. The reddish-brown spots form on the outer leaves and grow progressively worse, giving the head of lettuce an unattractive appearance.

ARS scientists compared the effectiveness of liquid nitrogen in tests with 15 paired trailers of precooled lettuce shipped from California to midwestern and eastern markets under three different cooling conditions: regular mechanical refrigeration; regular refrigeration plus nitrogen atmosphere; and nitrogen alone for cooling and atmosphere control.

Liquid nitrogen added to trailers cooled by conventional mechanical refrigeration produced the best atmosphere for preserving the lettuce. Trailers cooled only with liquid nitrogen became too warm and decay increased even though russet spotting was reduced because the nitrogen lowered the amount of oxygen in the atmosphere.

Horticulturists J. K. Steward and

J. M. Harvey, at the U.S. Horticultural Field Station, Fresno, Calif., prepared the lettuce for shipment.

Pathologists M. J. Ceponis, at Belle Meade, N.J., and W. R. Wright, at Chicago, evaluated market quality of the lettuce on arrival at these receiving points and after a simulated marketing period of 4 days at 50° F.

For the shipments, test cartons of lettuce were selected from the same fields to assure comparable quality of the lettuce in each paired trailer. Temperatures were recorded at several locations in each trailer throughout the trip. Average temperature of the nitrogen-cooled trailers was 41° F. while that of the trailers cooled by conventional refrigeration was 36° F.

Where liquid nitrogen was used in the tests, it was dispensed through a perforated tube running along the ceiling. It was circulated only by the force of its release from the tube and by convection.

The scientists believe that an effective cooling system using only liquid nitrogen is possible if some means of circulating it is used. They are working now to develop such a system.■

The lettuce below shows russet spotting. The russet-brown spots form on the outer leaves and grow progressively worse.

N–59127

PN–1477

Stability and fine texture are evident in frozen souffles made according to formulas developed by ARS utilization scientists. Souffle on left was made with whole eggs and flour; that on right, with egg white and no flour.

For Better SOUFFLES, MERINGUES

ARS RESEARCH may lead to expanded markets for frozen souffles and pie meringues and for the eggs that are their primary ingredient.

Utilization scientists have found that the problems of collapse and loss of fine texture in these frozen products can be reduced by making only minor changes in ingredients and processing methods.

Researchers Sheri Cimino, Lorraine Elliott, and Helen Palmer conducted the studies at the Western utilization research laboratory, Albany, Calif.

They found that slight increases in the amounts of flour and sugar used made souffles and meringues more stable. One of several stabilizers tested, methylcellulose, also proved beneficial in preventing collapse.

The utilization scientists also discovered that storage temperature is critical in some souffle and meringue formulas, and that baking before frozen storage produces flavor with more stability than baking after storage.

Whole-egg dessert souffles were more stable when flour content was increased from 4.5 to 7 or 8 percent. Souffles and meringues made with egg white but no yolk and no flour became more stable when sugar content was increased from 29 to 46 percent.

Unsweetened whole egg souffles also were improved when more flour was used. These souffles made with cheese were improved when cheese content was increased from 10 to 18 percent.

The best storage temperature, the researchers found, is between 0° F. and −10° F.■

GLASS PARTICLES SHOW HOW SOIL MOVES

GLASS PARTICLES THAT glow in the dark are helping an ARS scientist learn more about how soil is washed off fields.

His findings will give conservationists a better understanding of the erosion process and should lead to improved methods of preventing erosion.

Soil movement from rain-washed fields is a subject of keen interest to scientists. Erosion carries away fertile topsoil and contributes to silt buildup in streams. Chemical fertilizers and pesticides also wash off fields and add to stream pollution.

Agricultural engineer R. A. Young is using the fluorescent particles in research at the North Central Conservation Research Center in Morris, Minn., in cooperation with the Minnesota Agricultural Experiment Station.

In an attempt to learn what pattern of movement soil particles take when disturbed by rainfall, Young sprinkled fluorescent particles on a test plot and applied water with a rain simulator. At nightfall he could see the fluorescent specks with the aid of an ultra-violet light.

The pattern of movement of the particles wasn't exactly what Young had expected. "I found some particles 3 feet *upslope* from the spot I had applied them," he said. "Some particles moved as much as 6 feet *across* the slope." According to Young, this was the result of the random splash of the falling raindrops.

Young tested the material on a 15- by 35-foot plot of Barnes loam soil, sloped 5.5 percent, with corn rows running parallel to the slope. He distributed glass particles along the upper edge of the plot and applied simulated rainfall at the rate of 2½ inches per hour for 1 hour.

To make the fluorescent particles, Young mixed sodium diuranate with standard glassmaking ingredients—chiefly sand and soda. He chose sodium diuranate because it withstands the heat of the glassmaking oven. The engineer crushed the lumps of glass in a hammermill and sieved the particles so that they would correspond in size and specific gravity to the various-sized soil particles in the field.

The fluorescent particles have given Young a good indication of the pattern of movement soil particles take when disturbed by rainfall, but more research is needed. He also plans to use his glass "beads" on concave and convex slopes to determine how slope shape affects runoff and erosion.■

CANTALOUP LINE RESISTS VIRUS

AN ARS scientist at Beltsville, Md., has developed a cantaloup breeding line with the first known genetic resistance to watermelon mosaic virus (WMV–1).

WMV–1 is a major disease of cantaloup and watermelon crops. It occurs in Florida, Georgia, Texas, California, and Washington State. The virus reduces the amount and size of fruit that sets on the vine, and also causes discoloration of fruit and leaves. malformed leaves. and stunted plant growth.

The new breeding line, called B66–5, now makes it possible to breed commercial cantaloup varieties that are resistant to WMV–1. B66–5 is also resistant to the downy and powdery mildews that affect some cantaloup varieties.

ARS plant pathologist R. E. Webb believes that another ultimate value of the new breeding line may be a reduction in the occurrence of crown blight, a condition that causes plants to wither and die virtually overnight. Blight is caused by—among other things—a combination of viruses working together. and WMV–1 is suspected to be one of these.

Webb developed B66–5 after detecting the resistance to WMV–1 in a wild variety (PI 180280) from India. He crossed PI 180280 with the U.S. variety Seminole, backcrossed twice to Seminole, and then outcrossed to Edisto 47.

While B66–5 is important in cantaloup breeding because of its resistance to WMV–1, it is not resistant to some other common enemies of the cantaloup such as fusarium and verticillium wilts. And its reaction to alternaria leaf spot has not been determined.

B66–5 breeding material has been released to plant breeders.■

In Basic Applied Research . . .

Scientists Study the WIND

WIND IS ONE of the most elusive influences involved in plant growth and scientists are learning how to cope with it.

J. K. Radke, soil scientist at the ARS North Central Soil Conservation Research Center in Morris, Minn., grew rows of corn as windbreaks in a soybean field and boosted bean yields by 25 percent.

Agronomists at Cornell University, Ithaca, N.Y., placed trays of alfalfa in a wind tunnel, compared the water requirements of the plants in winds of ½ and 1½ mph, and found that the plants used water more efficiently at the higher windspeed.

As these experiments indicate, wind may either help or hinder crop development. Strong, hot winds, such as those that blow over the prairies of the Midwest, sometimes shrivel crops and damage stems and foliage. Light winds, however, help cool plants and also carry carbon dioxide to plant leaves for use in photosynthesis.

When they understand the intricate relationships of wind, light, and surface, scientists will be able to determine which plant intervals, field shapes, and other factors provide the best conditions for plant growth.

Radke's work in Minnesota provides farmers a simple, inexpensive technique for improving crop yields.

. . . corn rows as windbreaks

In tests, Radke planted double rows of corn at 40-foot intervals in the soybean plot. The corn rows were perpendicular to the prevailing southerly winds of the region. During the 3 years of the study, the experimental plot yielded an average of 26 bushels of soybeans per acre, compared to 21 bushel yields from an unprotected plot.

The corn displaced some bean plants, partly offsetting this gain. The corn, however, can also be harvested.

In a companion experiment, Radke used snowfences as windbreaks in a soybean field. They had virtually no effect on yield and were abandoned in favor of the corn windbreaks.

. . . windspeed and efficient water use

The research at Cornell is aimed at uncovering basic information on air motion and its relationship to crop growth. E. R. Lemon, ARS soil scientist, and L. A. Hunt and I. I. Impens, agronomists with the New York Agricultural Experiment Station, are cooperating in the work.

These scientists used light of three intensities on the plants in the wind tunnel. They found that rate of photosynthesis was highest in the plants subjected to the brightest light and the higher of the two windspeeds. These plants, however, used water more efficiently (in terms of dry matter gained and water lost) than the plants subjected to lower light intensities and windspeed.

Solar radiation furnishes the energy for wind motion; that is, heat absorbed by the earth's surface warms the air above and sets off the turbulence that we know as wind. Presumably, therefore, bright sunlight generates both increased photosynthesis and the wind necessary to supply the carbon dioxide required for the increased photosynthesis. However, the process is complicated by many factors, including the roughness of the ground surface on which the light is falling.■

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AGRISEARCH NOTES

Bacteria Draws Mosquitoes

Why do mosquitoes lay eggs in water? Scientists have found that some mosquitoes are attracted by the odor of bacteria and bacterial products in the water.

With this knowledge, scientists may be able to develop attractants that could be used to control the pests. Such attractants, for example, might lead mosquitoes to locations where they could be killed by insecticides without damage to fish or wildlife or might be applied in locations where eggs could not hatch.

In tests at Gainesville, Fla., entomologists E. I. Hazard and M. S. Mayer and technician K. E. Savage found that the southern house mosquito, *Culex pipiens quinquefasciatus*, a potential carrier of encephalitis, laid 93 percent of its eggs in a solution containing alfalfa. Later, it laid 95 percent of its eggs in water containing bacteria isolated from the alfalfa solution.

To learn whether odors attracted the mosquitoes, the scientists made further tests in darkness so that visual stimulation would not affect the insects. Odors of the hay solution attracted 66 percent of the southern house mosquitoes; bacteria odors attracted 78 percent.

The yellow fever mosquito, *Aedes aegypti* was not attracted by the odor from the alfalfa solution. However, the mosquito laid eggs in the solution when brought in close contact with it.

Limb Shaker Prevents Injury

Limb-type shakers, now widely used for harvesting fruits and nuts, sometimes injure the tree limbs, opening the way for disease.

But agricultural engineers P. A. Adrian of ARS and R. B. Fridley of the California Agricultural Experiment Station, Davis, are developing a shaker that eliminates this problem.

In tests of the new shaker, no bark injury occurred, and the vibration was as good as with other shakers. The shaker, still experimental, is not commercially available.

Some trees have nearly horizontal limbs that are difficult or impossible to shake with equipment now used, and shaker clamps often injure the limbs when not properly attached. Under certain conditions, the injury becomes infected by a fungus, resulting in a spreading canker that can girdle and kill the limb.

Field tests indicate the experimental shaker solves these two problems. It can be placed perpendicular to the horizontal limbs for shaking with reasonable effort and time, and the clamp is specifically designed to prevent abrasion and splitting of the bark.

The new machine incorporates a folding weight assembly that originates the shaking force. A single handle controls up and down, rotating, and tilting movement, and controls the shaker clamp and the motor. With this control handle, an operator can orient the shaker with a little practice.

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